

09/936530

PCT/NZ00/00029

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CERTIFICATE

(4)

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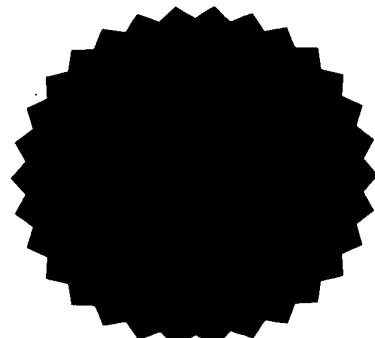
I hereby certify that annexed is a true copy of the Provisional Specification as filed on 16 March 1999 with an application for Letters Patent number 334694 made by MEGADOT SYSTEMS LTD.

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Dated 17 March 2000.

A handwritten signature in black ink, appearing to read "Neville Harris".

Neville Harris
Commissioner of Patents



334694

NEW ZEALAND

PATENTS ACT, 1953

No:

Date:

COMPLETE SPECIFICATION

IMPROVEMENTS RELATING TO HALFTONE PROCESSES

We, MEGADOT SYSTEMS LIMITED, a New Zealand company of 3/61 Taranaki Street, Wellington, New Zealand, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

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FIELD OF THE INVENTION

This invention relates to halftone printing processes and in particular to patterns of printing areas which may be used for preparing coloured images. These patterns include arrangements of the printing and non-printing areas which reduce the occurrence of moire and other effects in an image.

BACKGROUND TO THE INVENTION

Halftone processes suffer a number of problems including moire effects and colour shift.

Production of images using these processes involves a compromise between the perceptible impact of different undesirable effects. Reference is made to US 5,680,222 from the present inventor for background information on these effects.

Moire includes both large and small scale effects due to periodic alignment of the halftone dots which are used to represent different colours and black. Spurious patterns including lines and rosettes have frustrated printers for many years. Methods have been proposed to reduce these effects with varying degrees of success in varying circumstances.

Colour shift occurs when the dots of different colours or black overlap more or less than intended due to misregistration of their respective patterns. A slight displacement of the patterns or stretching of the print medium can cause an inaccurate reproduction of the original colours.

Traditional halftone patterns are "orthogonal" in that the printing areas lie on a square or rectangular mesh. Every colour "screen" generally takes the same format with a different spacing between the lines of the mesh and a different angle from horizontal. There have been few, if any, successful attempts to vary the orthogonal nature of the screens.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide patterns which can be used to reduce one or more of the undesirable colour related effects in halftone images. Accordingly the invention may broadly be said to consist in a combination of non-orthogonal patterns with common parcels of printing areas amongst at least some of the patterns.

In one aspect the invention may be said to consist in a screen system for use in production of a coloured halftone image, wherein: a plurality of screens each represent different colours or black in the image, each screen has a pattern of printing areas which defines a minimum mesh, each pattern has a parcel of printing areas which repeats throughout the 5 respective screen, and two or more of the screens have different non-orthogonal minimum meshes and have parcels which correspond in shape and size.

In another aspect the invention may be said to consist in a method of preparing halftone patterns for production of a coloured image, comprising: receiving information representing colour and tone variation in an image, creating a plurality of printing patterns which represent different colours or black in the image, forming each pattern from variable printing areas which define respective meshes and repeating parcels, at least two of the patterns having different non-orthogonal minimum meshes and corresponding parcels which are substantially similar in shape and size.

15 Preferably each minimum mesh is formed by two sets of parallel lines which lie along directions defined by equal shortest or shortest and next shortest distances between the printing areas.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described with respect to the drawings, 25 of which:

Figures 1a to 1d are four halftone patterns having a common tone density and different arrangements of printing areas,

Figures 2a to 2d are the four halftone patterns with each defining a non-orthogonal mesh over the printing areas,

Figures 3a to 3d are the four patterns with each defining a repeating parcel of printing areas,

30 Figures 4a and 4b are combined patterns and meshes for Figures 2a, 2c and 2b, 2d respectively,

Figures 5a to 5d are the four patterns with extended printing areas creating a darker tone,

35 Figures 6a and 6b are combined patterns and meshes for Figures 5a, 5c and 5b, 5d respectively,

Figure 7 demonstrates the combined patterns and meshes of Figures 2a to 2d,

Figure 8 demonstrates the combined patterns of Figures 5a to 5d,

Figure 9 is a flowchart indicating general processes by which a halftone image may be produced, and

Figure 10 is a schematic diagram indicating a computer-based system by which the processes of Figure 9 may be implemented.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings it will be appreciated that the various novel patterns must here be printed in black and white, and magnified by up to perhaps 1000x for the purposes of a clear description. It is not possible to demonstrate their full advantage under these circumstances. Also that the patterns and various shapes of the printing and non-printing areas may be implemented by an appropriate mathematical construction of a spot function or a threshold array, using a wide range of hardware and software which are already available. Details of the hardware and software are largely left to the skilled reader, with reference to US 5,680,222 and further references therein, for example.

A typical process for preparing a halftone image is outlined in Figure 9. In general terms the image is scanned or otherwise recorded by a suitable digital process and the resulting information is stored as pixel based colour and intensity data. The pixels are generally aligned with vertical and horizontal directions of reference such as the directions of scanner movement. This data is then processed into a standard format such as POSTSCRIPT and from there into a number of halftone patterns which are traditionally known as "screens". In current processes there may be four or more screens which represent a range of different colours and black, as required.

The patterns are generally created from the pixel information by raster image processing software commonly known as a "rip", which calculates the locations, spacings and shapes of the printing areas. An operator normally has a range of standard patterns installed on the equipment and may be able to develop variations of these patterns in some cases. Traditional calculations involve screen frequencies and angles although more sophisticated equipment enables patterns to be created without reference to these parameters. The operator is able to proof and modify the selection of patterns to minimise various effects such as moire, colour shift and tone jump according to the subsequent reproduction technique. A coloured image can be output in various ways depending on the manner in which the image will be published and the equipment which is available.

The patterns may be produced on film for inspection before printing plates such as used in offset printing are created. Sometimes the plates are produced directly. In other processes such as desktop publishing an image combining the patterns may be output directly through a laser printer or other printing device.

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Typical computer controlled equipment for production of halftone patterns and images is shown in Figure 10. The patterns are schematically indicated at the output stage according to the CYMK system which describes a coloured image in terms of the primary subtractive colours cyan, magenta, yellow and black. An image may be input to the system from a scanner 11, a computer tracing system 12, or from information already stored on a medium such as disk 13. An operator is able to process the input by way of controls on the scanner or the keyboard of the system 12. A separate dedicated system 13 is often used to convert pixel data into the halftone patterns. This includes a separate CPU 14 and screen processor 15 which contains the RIP. Output from the screen processor in this example is used to control the operation of a laser plotter 16 which produces film for use in production of plates for a printing press 19. Feedback control of the plotter involves a beam controller 17 and beam indicator 18. Details of the computer controlled equipment and alternative systems which might be used are beyond the scope of this specification.

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Figures 1a, 1b, 1c, 1d show four halftone patterns which might be considered as parts of different colour "screens" in a traditional printing system. In the present case however, they should be considered simply as patterns viewed from horizontal with respect to the image. They represent different colours or black in a general sense without limitation to screen related parameters such as dot frequencies and angles. The printing areas in each pattern are composed of conventionally shaped round dots which grow in size and shape in various ways, and may join in darker tones, according to variations in tone across the particular image. A uniformly light tone is presented by way of example and a similar pattern of non-printing areas would preferably appear in darker tones. It will be appreciated that a wide range of possible dot shapes and growths may be implemented in practice. It is primarily the arrangement of these printing areas with respect to each other which forms the subject of the present invention. The patterns might be considered as representing cyan, magenta, yellow and black in a typical four colour image.

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Figures 2a, 2b, 2c, 2d show the patterns of Figures 1a, 1b, 1c, 1d each with a superimposed mesh formed by two sets of parallel lines which pass through the dots. The meshes are "non-orthogonal" in that the sets of lines intersect at other than right angles

and are not perpendicular. Each mesh has a repeating unit which takes the shape of an oblique parallelogram such as a rhombus with four equal length sides or a rhomboid with two pairs of different length sides. The meshes are also "minimum" in that the sides of each parallelogram are formed by the shortest or second shortest distances measured
5 between the centres of the dots. The repeating unit may be either rhombus with four shortest sides or a rhomboid with two shortest and two second shortest sides. A large number of meshes may be defined for each pattern including both orthogonal and non-orthogonal lines. However, it is believed that any pattern can have only a single minimum
10 mesh of this kind. The minimum mesh is not necessarily used in calculation of the pattern but will usually be defined by consideration of a finished arrangement of printing areas determined by some other process.

Figures 3a, 3b, 3c, 3d show the patterns and meshes of Figures 2a, 2b, 2c, 2d each with a further superimposed mesh of a different kind. These meshes are orthogonal in this
15 example in that the two sets of parallel lines intersect at right angles, but may also be non-orthogonal. Each mesh therefore has a repeating unit or "parcel" which takes a more general range of parallelogram shapes including squares as shown, or rectangles, rhombii, rhomboids and so on. Still other non-parallelogram shapes able to repeat throughout a pattern may also be considered. These meshes are clearly not minimum meshes in that
20 their parcels typically include a relatively large number of printing areas on each side, although once again, a wide range of meshes having repeating parcels can be defined for a particular pattern. According to the invention, at least two of the patterns in an image have meshes with repeating parcels which correspond in shape and size, and preferably also in orientation as shown. Preferably all of the patterns have a common repeating
25 parcel, such as the squares which are shown here by way of example. The underlying non-orthogonal minimum meshes will usually but not necessarily be different as also shown. A process of forming a halftone image using patterns each having a non-orthogonal minimum mesh and also meshes of corresponding parcels is able to provide a substantial improvement in one or more effects including moire and colour shift. However, it will
30 be appreciated that acceptable effects may also be produced in images where only some of the patterns involve meshes of these kinds.

Figures 4a and 4b demonstrate pairs of patterns in combination showing their underlying
35 minimum meshes. They are taken from the patterns of Figures 2a, 2c and 2b, 2d respectively and could for example, represent combinations of cyan, magenta and yellow, black. The visual aspect of the combined patterns is somewhat deceptive in that the

different colours have different intensities in themselves, with yellow being considerably less intense than black. However, it will be seen that the printing areas in these patterns have been arranged in a way which reduces their overlap in light tones. It is impossible to eliminate all overlap throughout an image because the printing areas will necessarily grow and overlap in darker tones, with corresponding shrinkage and separation of the non-printing areas. However, it has been found that printing areas are conveniently arranged in this way with reference to a non-orthogonal mesh. If the patterns are also selected according to a common repeating parcel then the benefits mentioned above can be achieved.

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Figures 5a, 5b, 5c, 5d show the patterns of Figures 1a, 1b, 1c, 1d with preferred forms of dot growth in darker tones. In general terms the printing areas of each pattern become ovals which enlarge first in an initial direction as shown, and then in another. In each case however, the directions of growth are preferably towards nearby printing areas, and preferably differ between the patterns of a particular image. The areas of each pattern therefore join in two distinct stages resulting from their growth in two different directions. This reduces the effects of tone jump. The directions of growth preferably lie along the second and third shortest distances between printing areas as shown. Growth along the shortest distance can produce perceptible line aspects in the image.

Figures 6a and 6b demonstrate pairs of patterns in combination showing their initial directions of growth in the printing areas. They are taken from the patterns of Figures 5a, 5c and 5b, 5d respectively and could for example, represent combinations of cyan, magenta and yellow, black. For these particular combinations of colours the areas would normally grow in perpendicular directions.

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Figures 7 and 8 are provided as an attempt to demonstrate the nature of an image combining four patterns according to the invention. They are taken from the patterns of Figures 4a, 4b and 6a, 6b respectively. The absence of any significant moire effect is clearly seen although it is impossible to indicate the absence of other colour effects. Misregistration of the patterns does not cause any significant colour shift, for example.

WHAT WE CLAIM IS :

1. A screen system for use in production of a coloured halftone image, wherein:
a plurality of screens each represent different colours or black in the image,
each screen has a pattern of printing areas which defines a minimum mesh,
each pattern has a parcel of printing areas which repeats throughout the respective
screen, and
two or more of the screens have different non-orthogonal minimum meshes and
have parcels which correspond in shape and size.
2. A system according to claim 1 wherein:
each minimum mesh is formed by two sets of parallel lines which lie along
directions defined by equal shortest or shortest and next shortest distances between the
printing areas.
3. A system according to claim 2 wherein:
at least two of the minimum meshes are non-orthogonal in that the two sets of lines
are not perpendicular.
4. A system according to claim 1 wherein:
the parcels which correspond between the two or more screens have a
parallelogram shape.
5. A system according to claim 1 wherein:
the parcels which correspond between the two or more screens have a common
orientation.
6. A system according to claim 1 wherein:
the parcels are formed according to an orthogonal mesh.
7. A system according to claim 1 wherein:
the printing areas in darker tones extend along next shortest or longer distances
between the areas.
8. Computer apparatus which implements a screen system according to any one of the
preceding claims.

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9. A halftone image based on a screen system according to any one of the preceding claims.

10. A method of preparing halftone patterns for production of a coloured image, comprising:

receiving information representing colour and tone variation in an image,

creating a plurality of printing patterns which represent different colours or black in the image,

forming each pattern from variable printing areas which define respective meshes and repeating parcels,

at least two of the patterns having different non-orthogonal minimum meshes and corresponding parcels which are substantially similar in shape and size.

11. A method according to claim 10 wherein:

the non-orthogonal meshes are each defined by two sets of parallel lines which intersect at non-right angles.

12. A method according to claim 10 wherein:

the corresponding parcels are substantially similar in orientation.

13. A method according to claim 10 wherein:

the patterns each have different arrangements of printing areas within their respective parcels.

14. A method according to claim 10 further comprising:

joining the printing areas in darker tones along directions of second shortest or longer distances between the areas.

15. Apparatus which implements a method according to any one of claims 10 to 14.

16. A screen system for use in production of a coloured halftone image substantially as hereinbefore described with reference to the accompanying drawings.

17. A method of preparing halftone patterns for production of a coloured image substantially as hereinbefore described with reference to the accompanying drawings.

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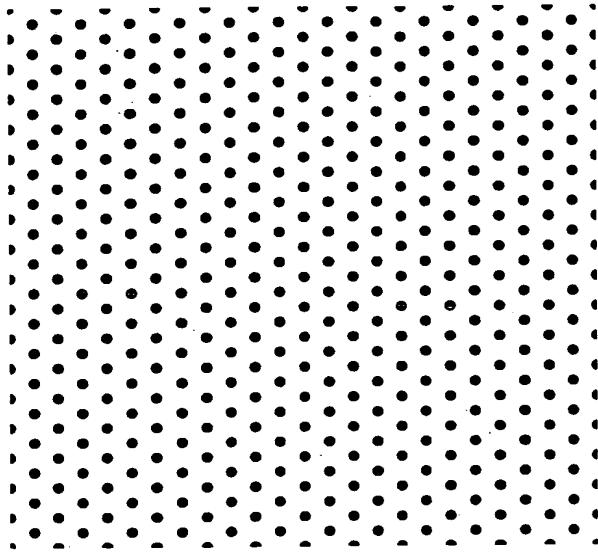


Fig 1a

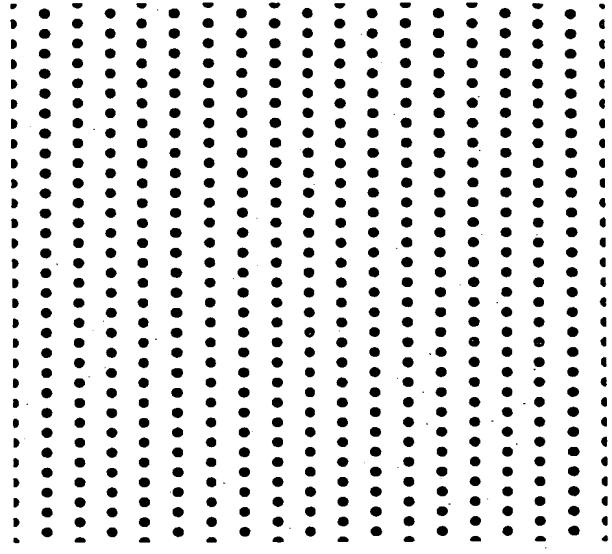


Fig 1b

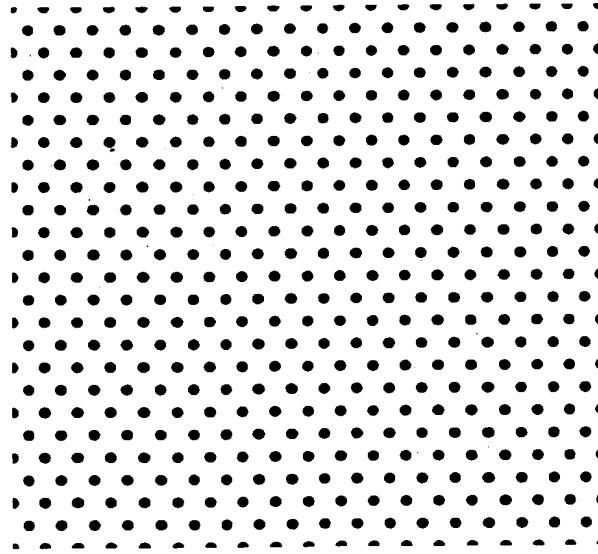


Fig 1c

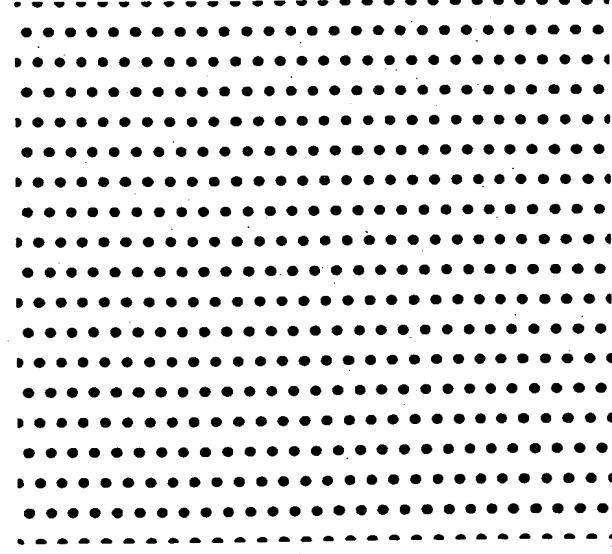


Fig 1d

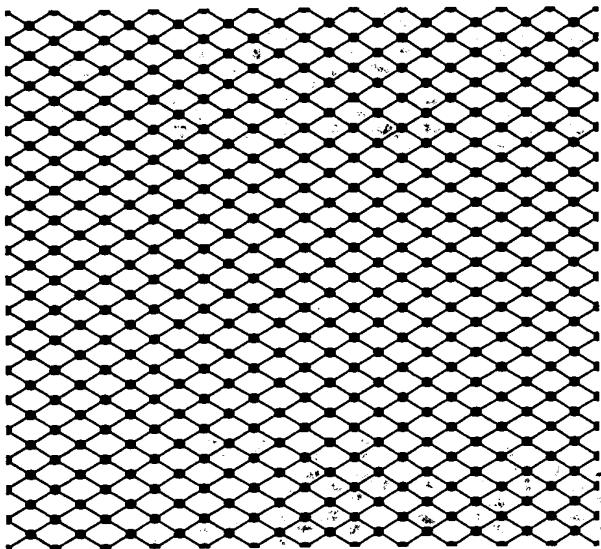


Fig 2a

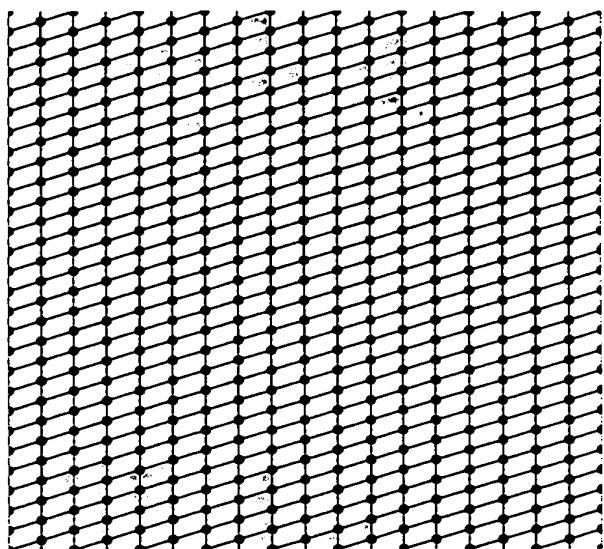


Fig 2b

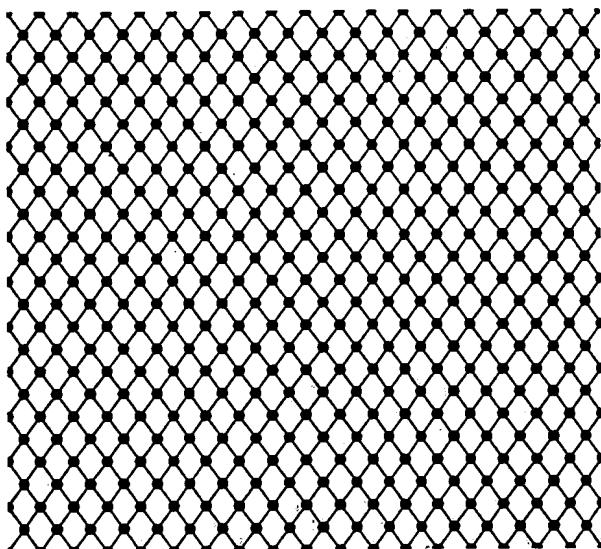


Fig 2c

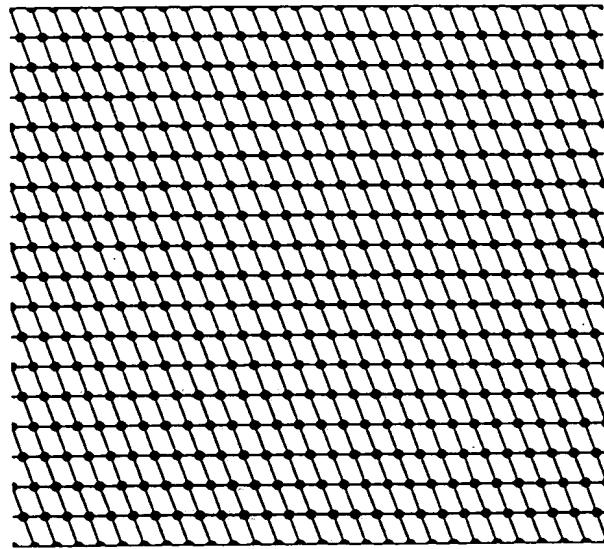


Fig 2d

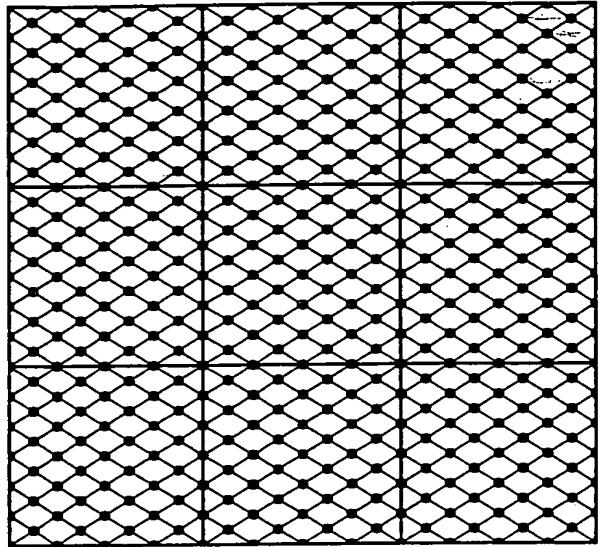


Fig 3a

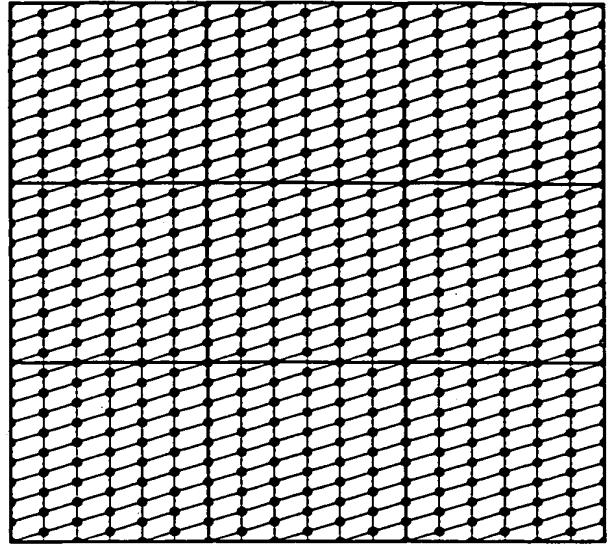


Fig 3b

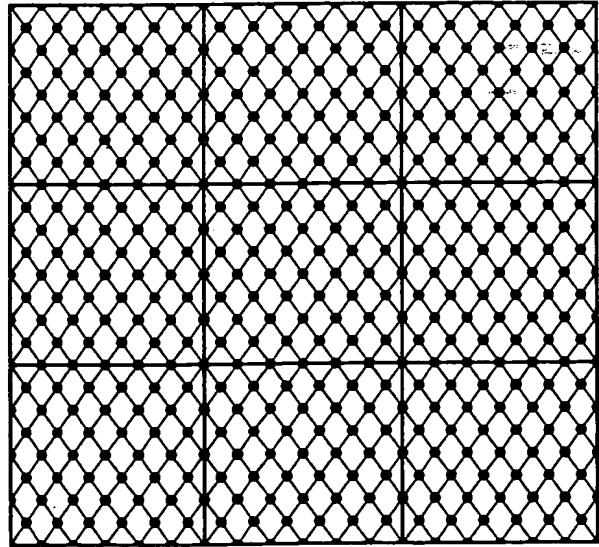


Fig 3c

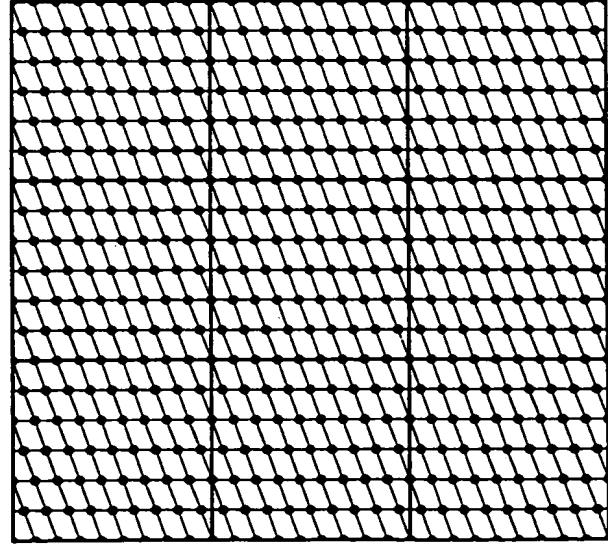


Fig 3d

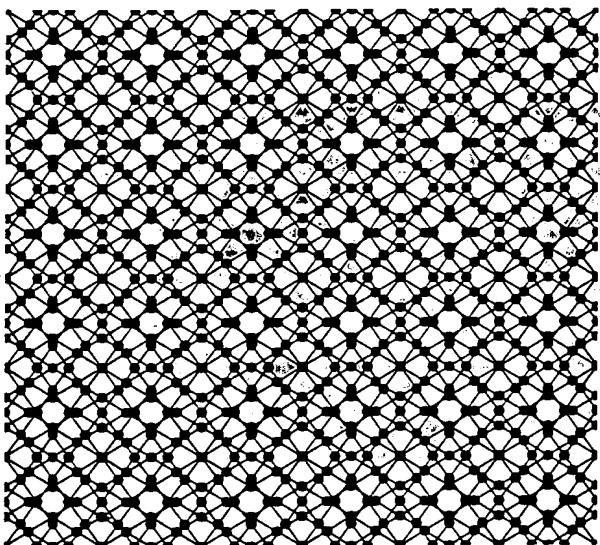


Fig 4a

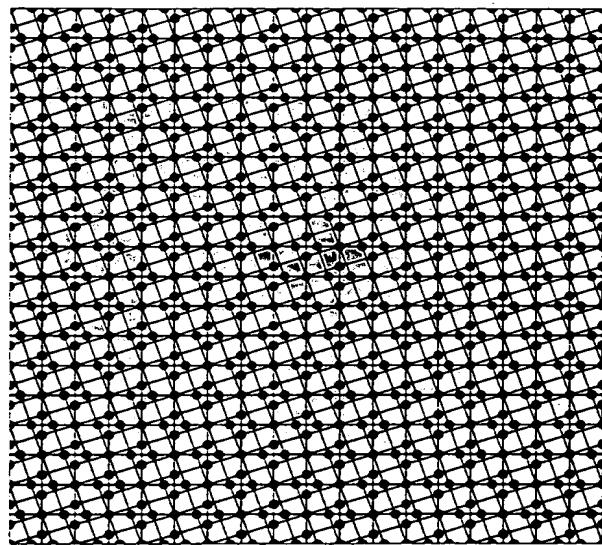


Fig 4b

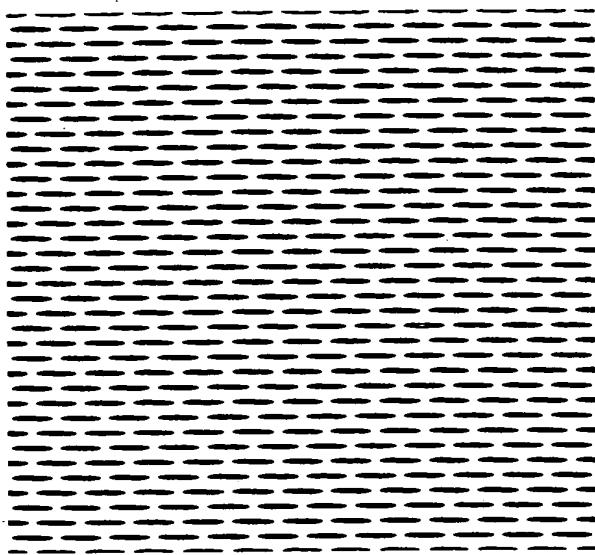


Fig 5a

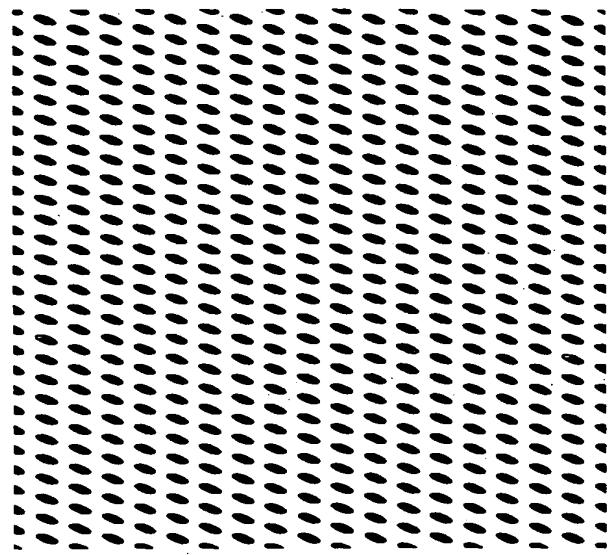


Fig 5b

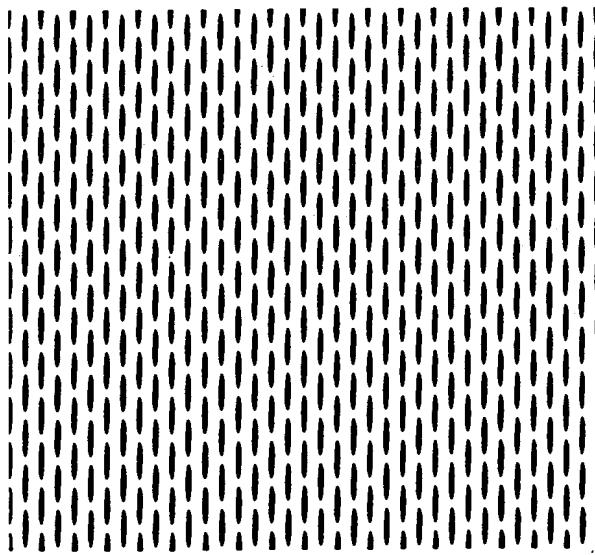


Fig 5c

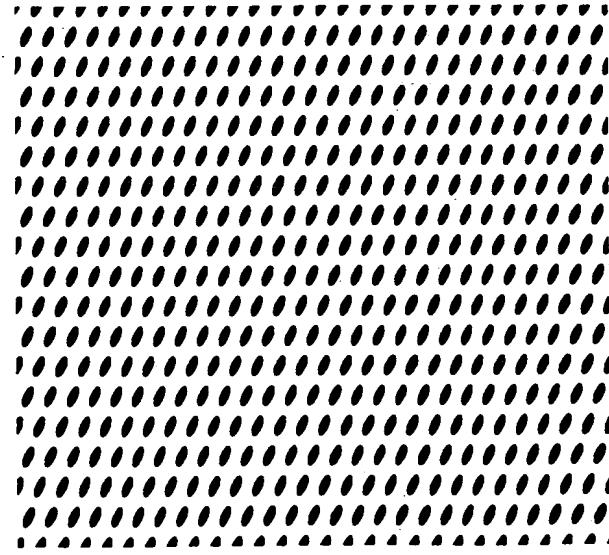


Fig 5d

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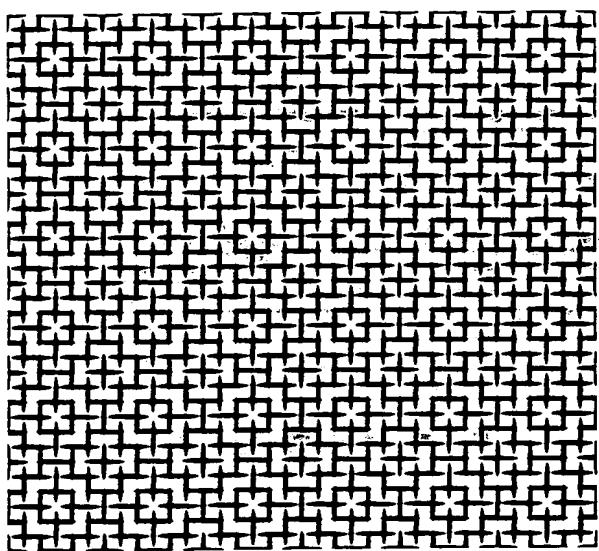


Fig 6a

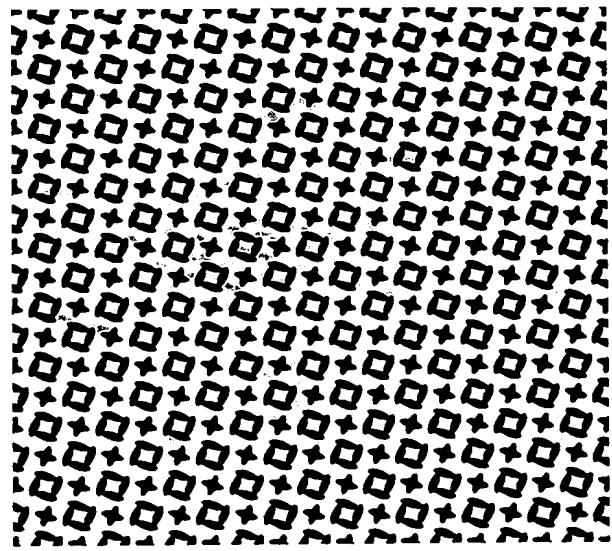


Fig 6b

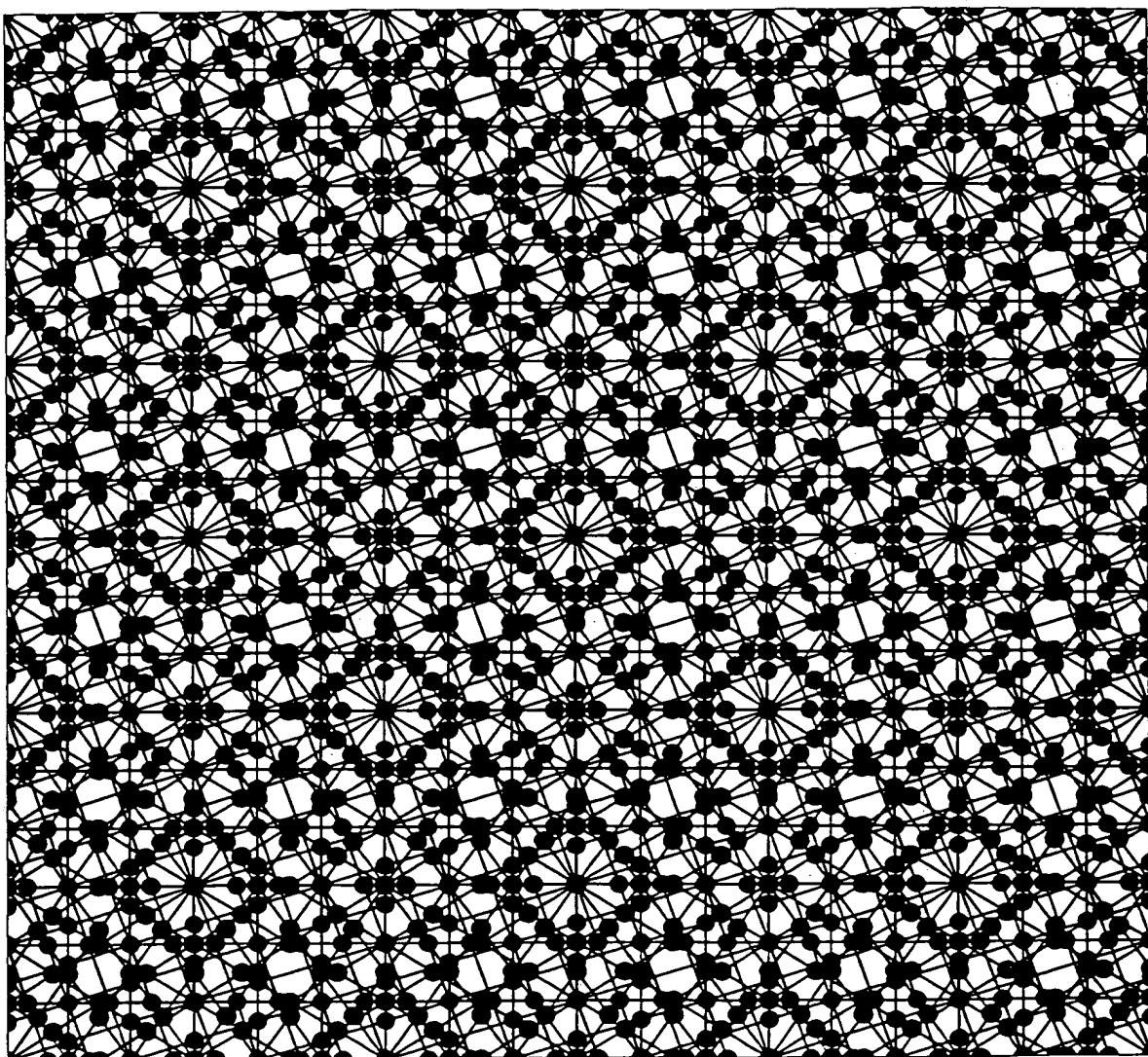


Fig 7

3a-5a

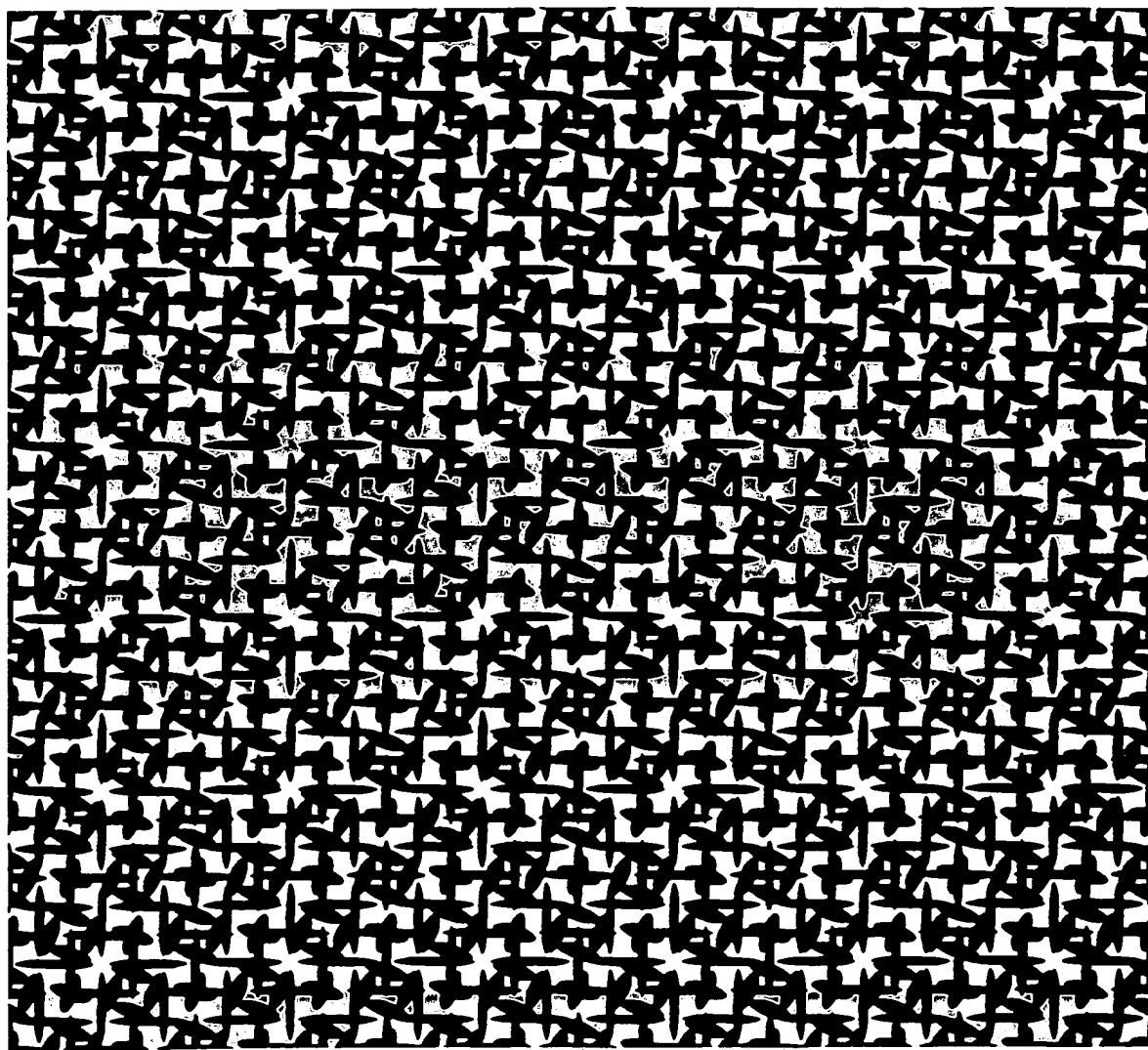


Fig 8

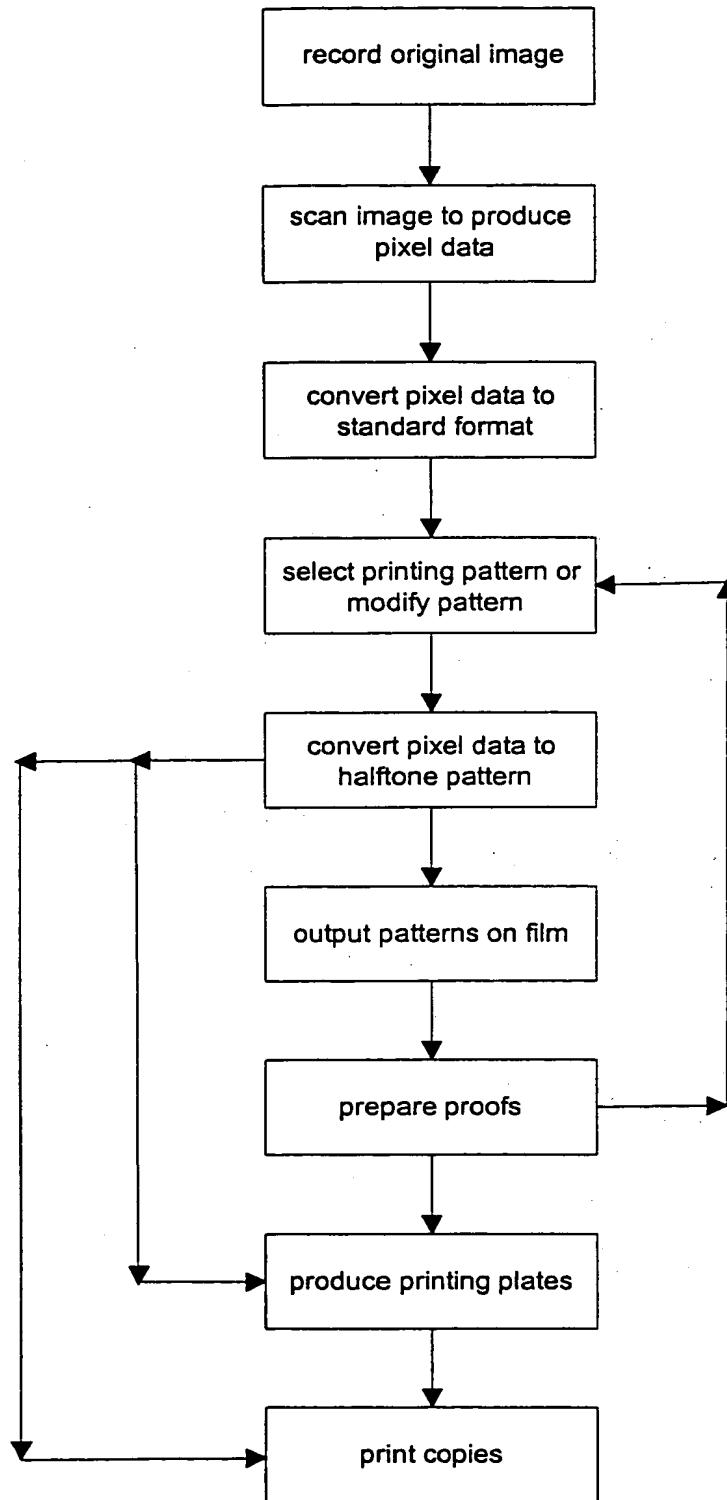


Fig 9

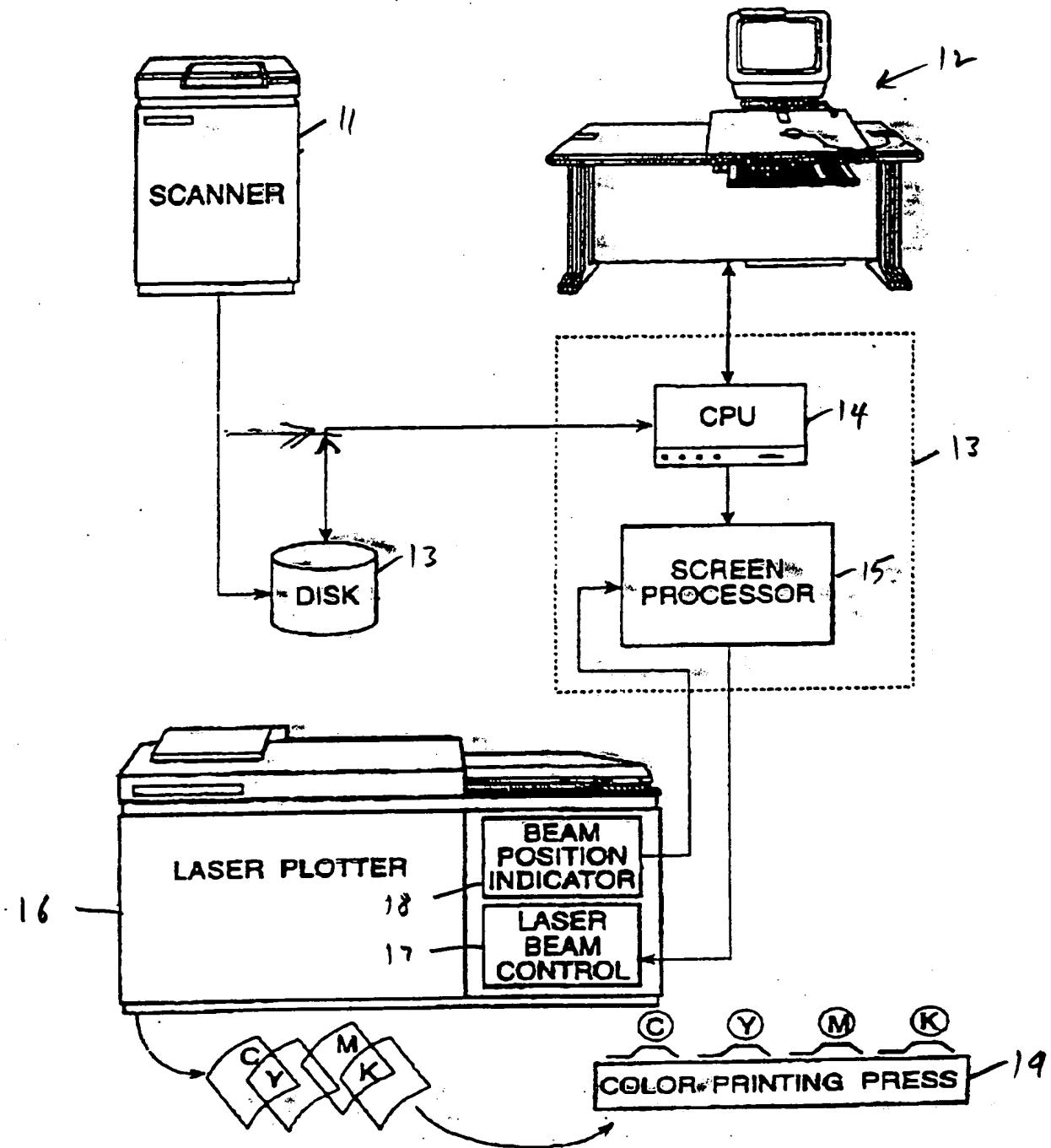


Fig 10